

# **Constructivist Classroom Activities for Biology Learning**

**Dr. Bharti Dogra**

Lecturer in Education

(Army Institute of Education, Ring Road, Kandhar Lines, Delhi Cantt.

Delhi -110010)

Telephone: 011-25683535

Mailing Address: Flat No. 11, Amit Apartments, Sector-13,

Rohini, Delhi-110085 (India)

E-mail: [bhartidogra1@yahoo.co.in](mailto:bhartidogra1@yahoo.co.in)

Telephone: 9810691945 (mobile)

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## Abstract

There are many learning theories in the educational process of teaching-learning. Constructivism is unique because it focuses on developing the learners' knowledge by constructing the world around them through experience, observation, documentation, analysis and reflection. In the classrooms of today, learners neither are no longer passive recipients nor are the teachers the all knowing '*givers of information, knowledge and wisdom*'.

According to constructivist perspective, the teaching or rather more precisely learning of biology is not the search for the ultimate truth. It is the process which is of utmost importance in biology than the content. So when the learning of biology involves active construction of knowledge by children, then the classroom environment must call for more synergies rather than mere individual participation. The teachers need to develop the ability to work with, children creatively to generate new ideas, new theories, new products and new knowledge. The engagement of the learner in the construction of classroom activity requires inputs from a reflective teacher and meticulous pre-planning before a unit is transacted in the class. Strategies of peer learning through group work, small work and whole class work are important, again depending on task and the teaching objective. Learner autonomy and respect for individual learners is mandatory if real learning is to take place. Encouraging learners to reflect and question their own understanding further aids comprehension. This paper discusses many classroom activities which encourage thinking, understanding, exploration, problem solving, collaboration, analysis, observation and prediction.

## **Constructivist Classroom Activities for Biology Learning**

Let us compare the biology teaching of two of my student teachers

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### **CLASSROOM – A**

#### **BIOLOGY TEACHER - PADAMAJA**

Padamaja was teaching 'Ecosystem' in her biology classroom. Padamaja considered science to be a body of knowledge to be learned. Her job was to "give out" what she (and the textbook) knew about science to her students. Thus the learning environment Padamaja tried to maintain in her classroom facilitated this transfer of knowledge; the desks were neatly in rows facing the teacher and the blackboard. Lecture notes and assignments from the text were given to students. Padamaja tried to keep students quiet and working all during the class period to ensure that all students could "absorb" the science knowledge efficiently. Another consequence of Padamaja's notion of teaching and learning was her belief that she had to cover so much that she had no time for laboratory activities.

Let's look at an example that typifies Padamaja's teaching style. Padamaja's students were to complete a worksheet that "covered" the concept of ecosystem. In this worksheet students were given certain exercises on food-chains like to fill the names of organisms at certain trophic levels. Some questions like what will happen if grass is missing in the

grass—deer---lion food chain were also included in the worksheet. After the students completed the worksheet, Padamaja went over the answers so the students could have the correct answers for the test later in the week. From a constructivist perspective, what opportunities did Padamaja's students have to relate the concept of ecosystem to their own experiences? Were these opportunities in Padamaja's lesson plan were provided to negotiate meanings and build a consensus of understanding? Padamaja spent one class period covering the concept of ecosystem; is that sufficient time for students to learn a concept with understanding?

### **CLASSROOM - B** **BIOLOGY TEACHER - ALKA BASU**

Alka Basu is another student teacher whose classes, in contrast, were inspired by constructivism. This student teacher was given four topics by her school biology teacher:

1. organization of the living world,
2. Nutrition,
3. Respiration and
4. Blood Circulation

Her classes were always student-centered and activity-based. At secondary level, she introduced students to above mentioned biology topics with short lectures, textbook readings, and confirmatory laboratories. After the introduction she would ask students what interested them about the topic and encouraged them to pursue and test these ideas. Students usually divided themselves into groups and then, conducted a library research, formulated questions/problems, and procedures to test the questions/problems. In other words, the students were acting as scientists in the classroom. In one class she was teaching students about ecosystem. Included in Alka's lessons were activities to "get the students involved. Students were shown the 'Aquarium' in the biology laboratory. They discussed:

- different food-chains in this man-made ecosystem

- how different living organisms depend on each other in an ecosystem
- use of dissolved oxygen in water by aquatic plants and animals
- what happens if any particular trophic level is missing in the food-chain?

Students were also involved in role-play activity where they played the roles of different plants and animals in different food-chains. They used certain props and few dialogues in the role-play activity. Few cases were also discussed where when the rain forest was cut then many of the animals became extinct due to destruction of their habitat. Then a few animal sanctuaries were discussed to highlight the importance of habitat for wild animals. Alka spent two weeks teaching this topic on *ecosystem*. Were Alka's students given opportunities to make sense of the concept of ecosystem? Were they able to use personal experiences? Whose students do you think had a deeper understanding of ecosystem?

A close understanding of the two classrooms has revealed the following points of difference between them.

	<b>CLASSROOM – A</b>	<b>CLASSROOM – B</b>
<b>MATERIALS</b>	Primarily textbook	Includes Primary sources and other resources
<b>LEARNING</b>	Based on repetition, explanation by the teacher.	Interactive and build on what the student already knows.
<b>KNOWLEDGE</b>	Seen as inert, to be passed on from teacher to taught	Seen as dynamic, ever changing, to be constituted by the learner.
<b>TEACHER'S ROLE</b>	Giver of information, rooted in authority	Creative collaborator, facilitator, mentor, guide <b>who</b> moderates, suggests, coaches
<b>STUDENT'S ROLE</b>	Passive recipients of knowledge	Interactive, construct their own knowledge based on previous experiences, ask questions, explore, experiment, reflect, discuss
<b>TRANSACTION STRATEGIES</b>	Teaching facing class	Group Work and Pair Work, using peers as Resources

<b>APPROACH</b>	Lecture method, teacher asking questions as well as answering them,	Construction of meaning by learner by formulating their own questions-inquiry allowing multiple interpretations and expressions of learning – multiple intelligence encouraging collaborating learning
<b>LEARNING PROCESS</b>	Teacher led class,  Students are not used as a resource for learning.	Students' full participation in learning activities such as projects and hands-on experiments. Collaboration among students, peer teaching helps them to review and reflect on their learning processes and pick up strategies and methods from one another

As a teacher educator in Army Institute of Education, I got the privilege of supervising the biology classes of a number of students. Here I have mentioned the biology classroom teaching of only two students – Padamaja and Alka Basu.

For many years the conventional wisdom of teachers has been similar to Padamaja's teaching style: to control student behavior so that the class is quiet. Most of the time there was an oral-expositive teacher participation. Teachers in many cases are not aware of the practices or strategies to help students in *constructing knowledge*. Alka Basu believed in child-centered methods. Alka Basu in her classes never forced students to stay quiet but rather she managed the classroom in such a way that they must get ample opportunities to talk with one another and utilize collaborative learning strategies. Alka Basu encouraged students to visit school library for referring books and other self-learning materials. She encouraged students to create a small library corner in the classroom. A list of selected websites related to each topic was also given to the students before hand to provide them an idea about the content. Certain advanced organizers were also given to the students to set the pace for teaching. Students were encouraged to reflect and question their own understanding. The central point of Alka Basu's teaching was to elaborate original concepts, in an enjoyable and enthusiastic way.

## What is Constructivism?

Constructivism is a learning theory based on scientific observation and research and explains how people learn. They construct their own knowledge of the world around them through reflection on their experiences. When we are faced with new knowledge, we tend to relate it to our previous experiences and either modify our ideas or discard the new information. In the process we tend to create new knowledge by asking questions, explaining and assessing what we already know

Constructivism as applied to education is a more recent development derived from the work of development psychologist *Jean Piaget (1973)* and Russian psychologist *Lav Vigotsky (1978)*. Its underlying principles are also influenced by the developmentalist ideas of the French philosopher *Jacques Rousseau* and later the theories of *John Dewey*, *G Stanley Hall* and *Arnold Gessell*.

## National Curriculum Framework (2005)

In this path breaking document by NCERT, the constructivist approach and its implications for practice have been brought out in great detail. Some of the key principles are summarized below:

- In the constructivist perspective, learning is a process of construction of knowledge
- Learners actively construct their own knowledge by connecting new ideas to existing ideas on the basis of materials/ activities presented to them (experience).
- The structuring and restructuring of ideas are essential features as the learners' progress in learning.
- The engagement of learners, through relevant activities, can further facilitate in the construction of mental images of the relationships (cause-effect)
- Collaborative learning provides room for negotiation of meaning, sharing multiple views and changing the internal representative of external reality.

## Constructivism in Biology Education

From a constructivist perspective, biology is not the search for truth. It is a process that assists us to make sense of our world. Using a constructivist perspective, teaching biology becomes more like the biology that biologists do; it is an active, social process of making sense of experiences, as opposed to what we now call "school biology." Indeed, actively engaging students in science (we have all heard the call for "hands-on, minds-on science") is the *goal of most science education reform*. It is an admirable goal, and using constructivism as a referent can possibly assist in reaching that goal

In a constructivist epistemology

- tools available to a knower are the *senses*. It is only through seeing, hearing, touching, smelling and tasting that an individual interacts with the environment. With these messages from the senses the individual builds a picture of the world.
- Experience involves an interaction of an individual with events, objects, or phenomenon in the universe; an interaction of the senses with things, a personal construction which fits some of the external reality but does not provide a match.
- A cooperative learning strategy allows individuals to test the fit of their experiential world with a community of others. Others help to constrain our thinking. The interactions with others cause perturbations, and by resolving the perturbations individuals make adaptations to fit their new experiential world.
- The process of learning should not stop at what has been learned in the negotiation of a class consensus. This process can involve accessing other learning resources such as books, videotapes, and practicing scientists.

## Constructivist Classroom activities in Biology Learning

Knowledge is constructed by the learner, not received. How does knowledge construction (i.e. learning) take place? Learners come to biology learning with existing ideas about many natural phenomena? What ideas do learners' bring to biology classes?, and what is the nature of these ideas? Each individual has a unique set of ideas. How much commonality is there between learner's ideas in biology? The learners' existing ideas

have consequences for the learning of biology. How do learners' ideas interact with teaching? It is possible to teach biology more effectively if account is taken of the learner's existing ideas. How should ['constructivist'] teachers teach biology? There are a number of ways by which teachers can come to know about the previous knowledge of students. Some exercises are mentioned in this section:

1. **Concept maps** - In the study of Biology, the ability to build interrelationships among concepts and related topics, and to relate newly acquired knowledge to prior knowledge, is crucial to the understanding of biological concepts and how the systems work together to bring about a coordinated response. Concept maps, diagrams and other graphic organisers are useful tools to illustrate the links between concepts and topics. Once a teacher has explained ecosystem, ask students to connect the following terms: *ecosystem, biotic components, abiotic components, soil, water, air, decomposed organic matter, CO<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, water, climatic conditions, temperature, producers, consumers, decomposer, food-chain, energy flow, recycling of nutrients and biogeochemical cycles*. Every term should be connected with arrows labeled with a word that describes the link between the processes – example: change, causes, provides, directs, etc.

When students are able to discover the links between concepts themselves, they move away from rote or surface learning, and replace it with deep and meaningful learning, thus increasing the level of understanding and an appreciation for the subject. This encourages cooperative learning also.

2. **Use of newspaper articles in making T-charts** –Tell students to bring newspaper articles about science. List the topics of the articles on the board as the students give a 30 second summary of their article. From this list choose 5-6 topics which are relevant for them. Make 5-6 groups of students and allocate one topic to each group. Give each group instructions to make a T-chart on a large piece of chart paper. Tell them that a T-chart is a large T drawn on the paper...with the topic written at the top of the T. On one side of the T bar students will write “what

have you heard about the topic?” On the other side they will write “what questions do you have about the topic?”

Now you can discuss these T-charts either in the construction of the concept maps or can understand their previous knowledge to initiate discussions in the class.

- 3. *Scenarios*** - You are discussing homeostasis in living organisms. The students are now part of a multi-disciplinary team put together to design “the perfect animal” that can survive and reproduce successfully under the following conditions: an environment that is very hot and dry during the day, but turns cold and windy at night, and that has many fast and aggressive predators. In their design of this animal, they should consider integument, body support, reproductive strategy, excretion and mode of locomotion.

In this exercise students need to think, work in a group, discuss and apply already covered/taught topics like adaptations, thermoregulation, morphological features, life-processes, defense mechanism etc. This requires structuring and restructuring of concepts which is possible only with good understanding of concepts. Learning benefits from multiple views of a subject area.

- 4. *Graphs*** - After studying human growth, ask students to draw a graph of average growth after birth showing the relationship between heights (in cm.) and age (years). Once they have made this graph then tell them to plot a graph of male and female comparative growth rates showing the relationship between change in height (cm/year) and age (years).

This graphical representation helps in better understanding and interpretation.

- 5. *Brainstorming*** - When reviewing thermoregulation, ask students to come up with five ways in which snakes can prevent overheating on a hot summer day.

This exercise helps in developing thinking skills, structuring and restructuring of conceptual knowledge.

- 6. *Observations/Predictions*** - When you are about to explain the hormonal control of female reproductive system, show an illustration of hormonal control of female reproductive system and ask students to make a list of six observations. When you discuss the positive and negative feedback systems controlling the production of estrogen and progesterone by the ovary with the students, they have already spent time studying the names of different glands involved and hormones produced by them and will be more receptive to learn more about the role of hormones in ovulation and menstruation. Then, ask students to predict what would happen to the endometrium if progesterone level does not fall during the last days of the menstrual cycle?

This exercise will help students in observation, comprehension, analysis, interpretation and prediction.

- 7. *Problems*** - This problem is designed to help students understand the functioning of the circulatory system in the human body. Suppose you are staying on the second floor of the building and due to low pressure of the water, the water reaching your taps is not sufficient. Then you are advised to install water pump at your house. Predict:

- What will happen?
- What if there is any blockage in the water pipes supplying water to your house taps?
- What will happen if you now shift to the ground floor flat?

This activity provides an analogy to understand circulatory system in human beings. This helps in better understanding of the organ system (circulatory system) as well as its functioning.

- 8. *Use of Cartoons*** – Use of cartoons in classroom teaching can make learning joyful. One page cartoons can be shown to the students like a cartoon showing a small boy holding his stomach with both hands and his face is looking very

painful. On one side of the boy is shown the inner view of his stomach. Inside the stomach a lot of bacteria are jumping and releasing a lot of gas. Now teacher can ask questions like:

- what is happening in the stomach of this boy?
- name that part of the digestive system in which these bacteria are present.
- name the foods which are likely to produce more gas.
- how can we avoid flatulence/stomach discomfort?

This exercise helps in making learning an enjoyable experience. The engagement of learners, through relevant activities, can further facilitate in the construction of mental images of the relationships (cause-effect).

**9. *Songs for teaching biology*** – There are many songs which can be used for promoting learning in a joyful manner. One such song is given below:

### **Ecosystems**

Science Maniacs

(Chorus)

I've got a big pond in my backyard  
 It's my own little ecosystem working hard  
 All the organisms are part of the food web  
 They play specific roles to make sure that they all get fed

The grasses growing on the edge and the algae in the water  
 The producers photosynthesize with light, CO<sub>2</sub> and water  
 CO<sub>2</sub> is in the air, the light comes from the sun  
 They produce the oxygen and the food needed by everyone

(Chorus)

Some snails eat the algae and some snails eat the grass  
 They're the primary consumers 'cause they eat only plants  
 And even when the grass has died there's still some energy left  
 For the decomposers, dead things are what they like best

(Chorus)

The fish eat the snails and the turtles eat the fish  
 And every time that one of them eats it only gets 10%  
 So every gram of turtle needs 10 grams of fish  
 A gram of fish needs 10 grams of snails to fulfill its energy requirements

(Chorus)

An ecosystem relies upon this energy pyramid  
 It takes an awful lot of plants to let 1 turtle live  
 1000 plants, 100 snails, 10 fish would be just right  
 To keep 1 turtle well fed and it all starts out with light

(Retrieved from <http://www.songsforteaching.com/biologyecology/ecosystems.htm>)

## Let us Sum Up

Constructivists claim that we have no access to an objective truth and that all knowledge is subjective and dependent on the learner. From a constructivist perspective, science is not the search for truth. It is a process that assists us to make sense of our world. Using a constructivist perspective, teaching biology becomes more like the biology that biologists do - it is an *active, social process of making sense of experiences*. It is an enjoyable activity and the role of the teacher is very challenging.

Learning in classrooms is facilitated by well designed activities. These activities offer the opportunity to examine the problem from a variety of perspectives and also to collaborate. Listening to the multiple views on the subject makes the understanding better. Through different classroom activities, students get an opportunity to reflect and

build on and consolidate existing knowledge. Students get an opportunity to construct knowledge.

Just as teachers have to learn how to teach from a constructivist point of view, so too must students learn how to learn. Educating students to be effective learners is an important priority in establishing environments conducive to effective learning of biology.

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